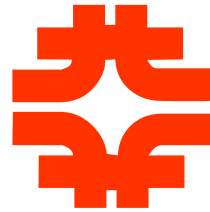
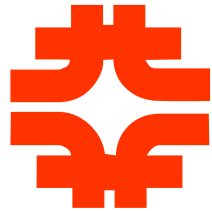


Beams Division Preparation for Run IIb



Dave McGinnis

June 11, 2001



Run II Luminosity Goals

- The luminosity goal for Run IIa is 2 fb^{-1}
 - Peak luminosity up to $2 \times 10^{32} \text{ cm}^{-2} \text{ sec}^{-1}$
 - Switch to 103 bunches at $1 \times 10^{32} \text{ cm}^{-2} \text{ sec}^{-1}$
 - Length of Run IIa is about 2 years

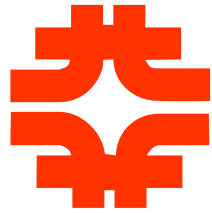
- The luminosity goal for Run IIa+Run IIb is 15 fb^{-1}
 - Increase antiproton intensity by 2-3
 - Peak luminosity up to $5 \times 10^{32} \text{ cm}^{-2} \text{ sec}^{-1}$
 - 103 bunch operation
 - Length of Run IIb is about 4 years



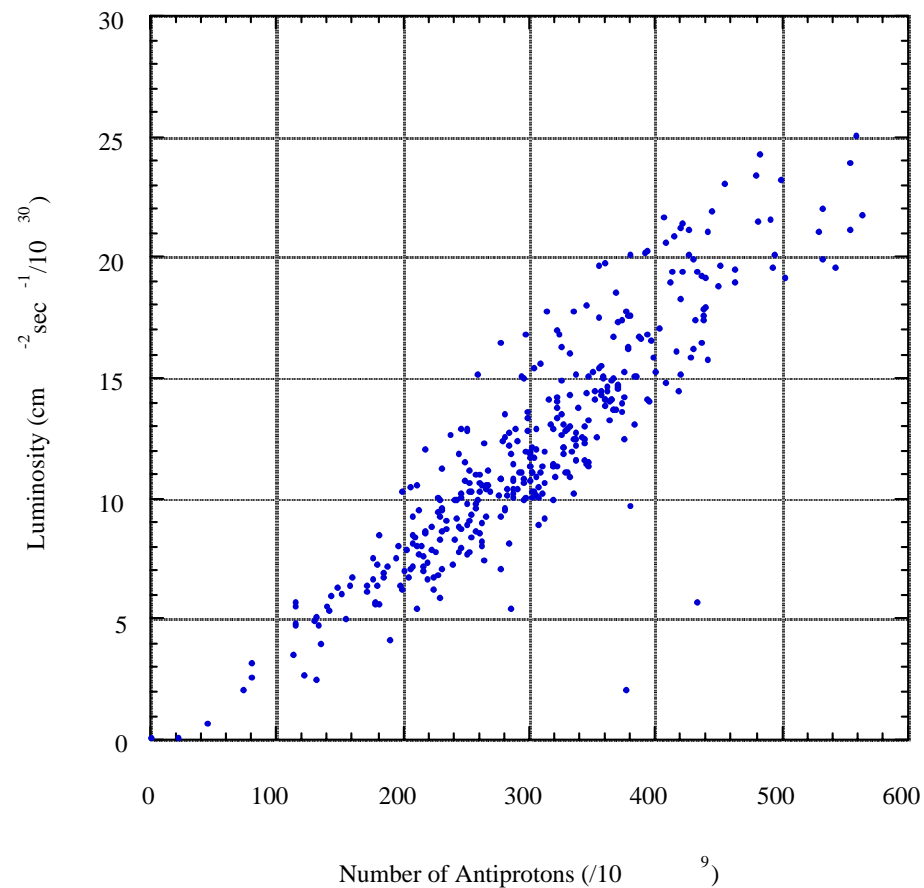
Run II Parameters

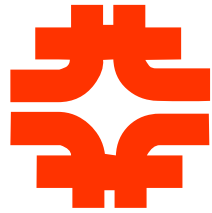
RUN	Ib (1993-95) (6x6)	Run IIa (36x36)	Run IIa (140x105)	Run IIb (140x105)	
Protons/bunch	2.3×10^{11}	2.7×10^{11}	2.7×10^{11}	2.7×10^{11}	
Antiprotons/bunch*	5.5×10^{10}	3.0×10^{10}	4.0×10^{10}	1.0×10^{11}	
Total Antiprotons	3.3×10^{11}	1.1×10^{12}	4.2×10^{12}	1.1×10^{13}	
Pbar Production Rate	6.0×10^{10}	1.0×10^{11}	2.1×10^{11}	5.2×10^{11}	hr ⁻¹
Proton emittance	23π	20π	20π	20π	mm-mrad
Antiproton emittance	13π	15π	15π	15π	mm-mrad
β^*	35	35	35	35	cm
Energy	900	1000	1000	1000	GeV
Antiproton Bunches	6	36	103	103	
Bunch length (rms)	0.60	0.37	0.37	0.37	m
Crossing Angle	0	0	136	136	μrad
Typical Luminosity	0.16×10^{31}	0.86×10^{32}	2.1×10^{32}	5.2×10^{32}	cm ⁻² sec ⁻¹
Integrated Luminosity [†]	3.2	17.3	42	105	pb ⁻¹ /week
Bunch Spacing	~3500	396	132	132	nsec
Interactions/crossing	2.5	2.3	1.9	4.8	

[†]The typical luminosity at the beginning of a store has traditionally translated to integrated luminosity with a 33% duty factor. Operation with antiproton recycling may be somewhat different.



Luminosity vs. Antiproton Intensity



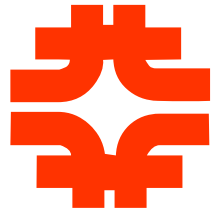


The Run IIb Plan

To obtain 15 fb^{-1} by 2007 we need to:

Increase the number of antiprotons in the collider by a factor of 2-3 over Run IIa

- without major interruption to Run IIa
- within a period of 2-3 years
- with a budget of about \$35 M



More Antiprotons

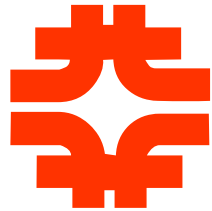
- More protons on the antiproton target ($\sim 1.8 \times$)

- Slip stacking

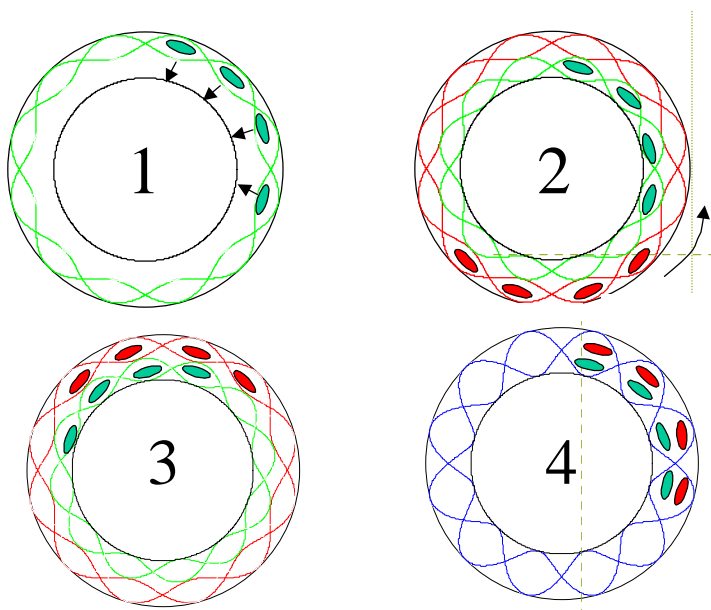
- MI Beam loading compensation
 - Booster Cogging
 - Proton beam sweeping

- Brighter Proton Source

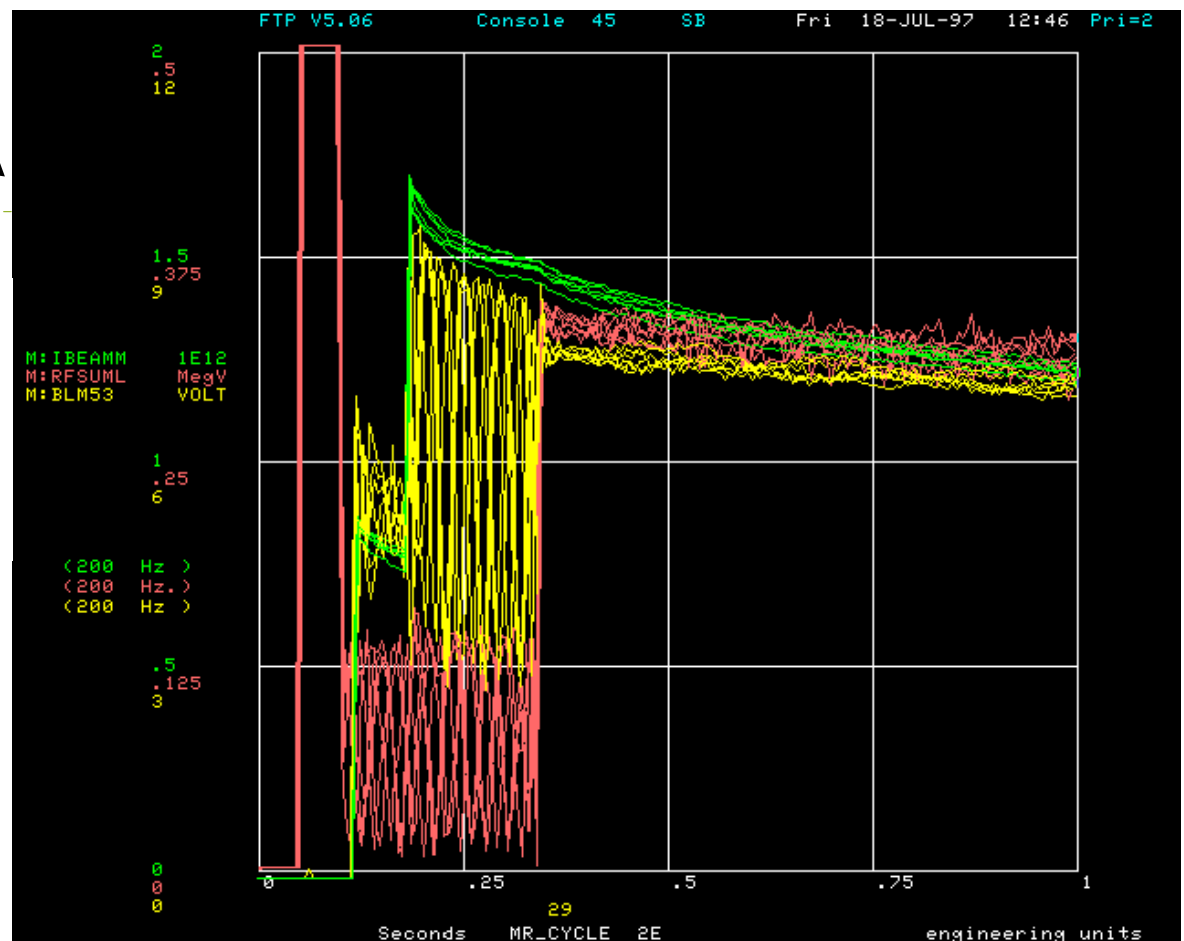
- Brighter Ion Source
 - New Linac front-end acceleration stage

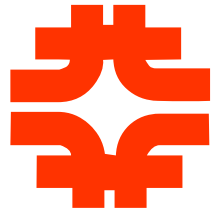


Slip Stacking



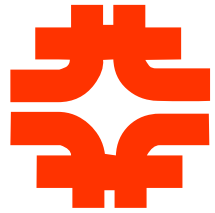
M:IBEAM=beam current (dc)
 M:RFSUML=rf voltage fanback
 M:BLM53=beam current at 53 MHz



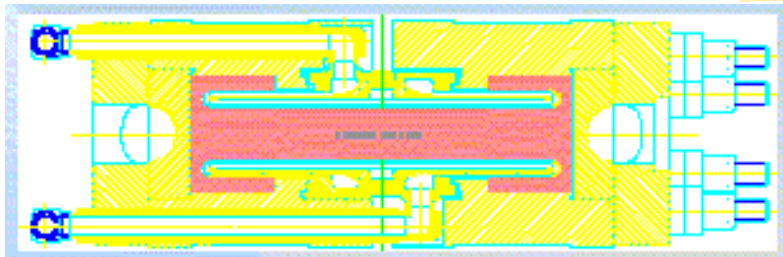


More Antiprotons

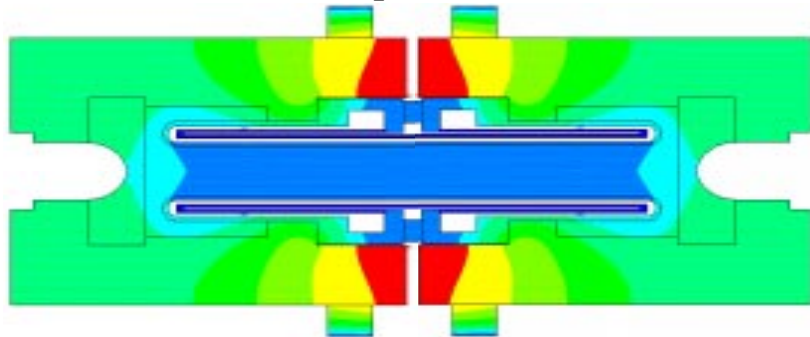
- Better antiproton collection efficiency
 - Lithium lens Upgrade (~1.5 x)
 - Solid lens redesign
 - Liquid Lithium lens
 - AP2-Debuncher aperture increases (~1.5 x)
 - Physical aperture increases and beam based alignment
 - Debuncher lattice Upgrades



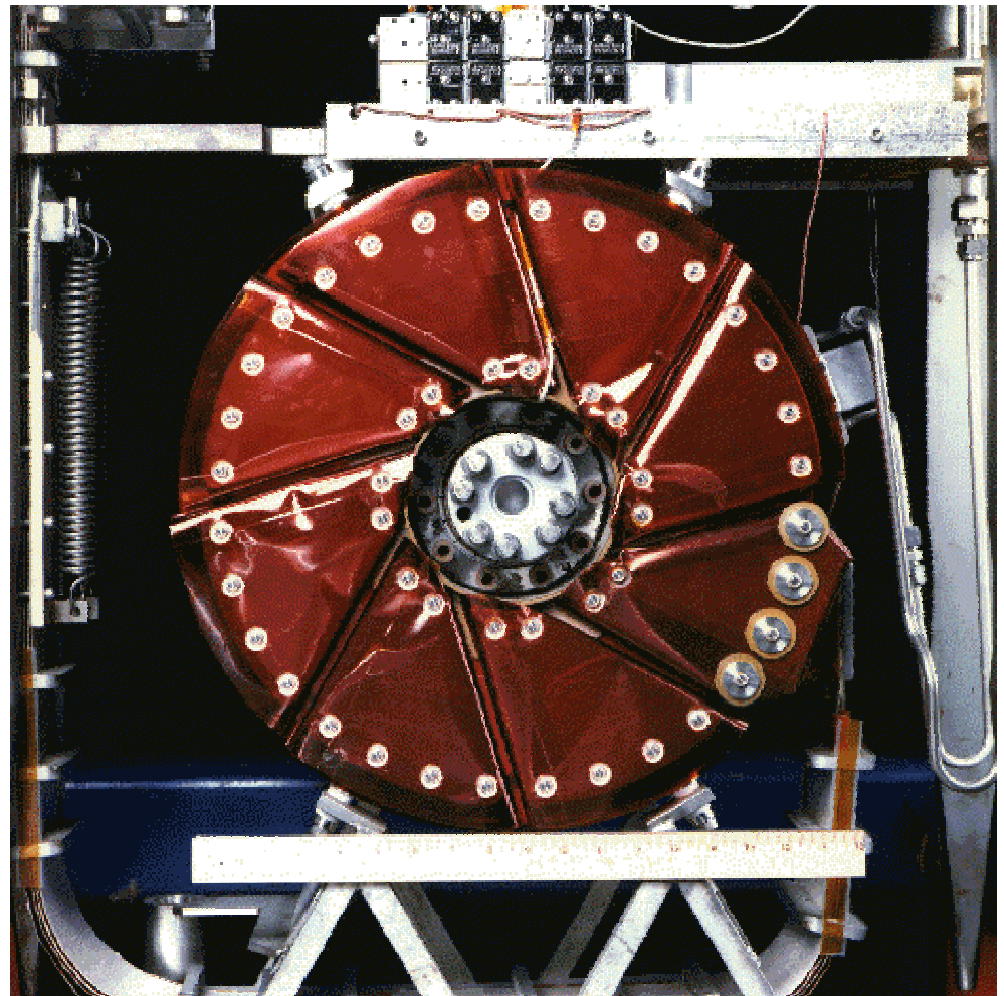
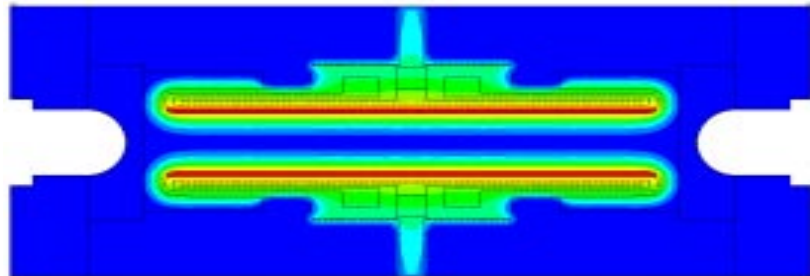
Lithium Lens

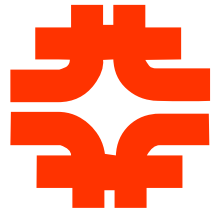


Temperature



Magnetic Field





Handling the Increased Antiproton Flux

- Better cooling

- Debuncher cooling bandwidth increase

- Accumulator Stacktail

- Gain slope redesign

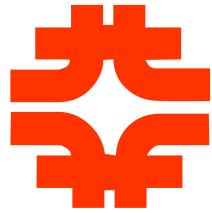
- Betatron Cooling

- Accumulator Core bandwidth and sensitivity increase

- Electron cooling in the Recycler

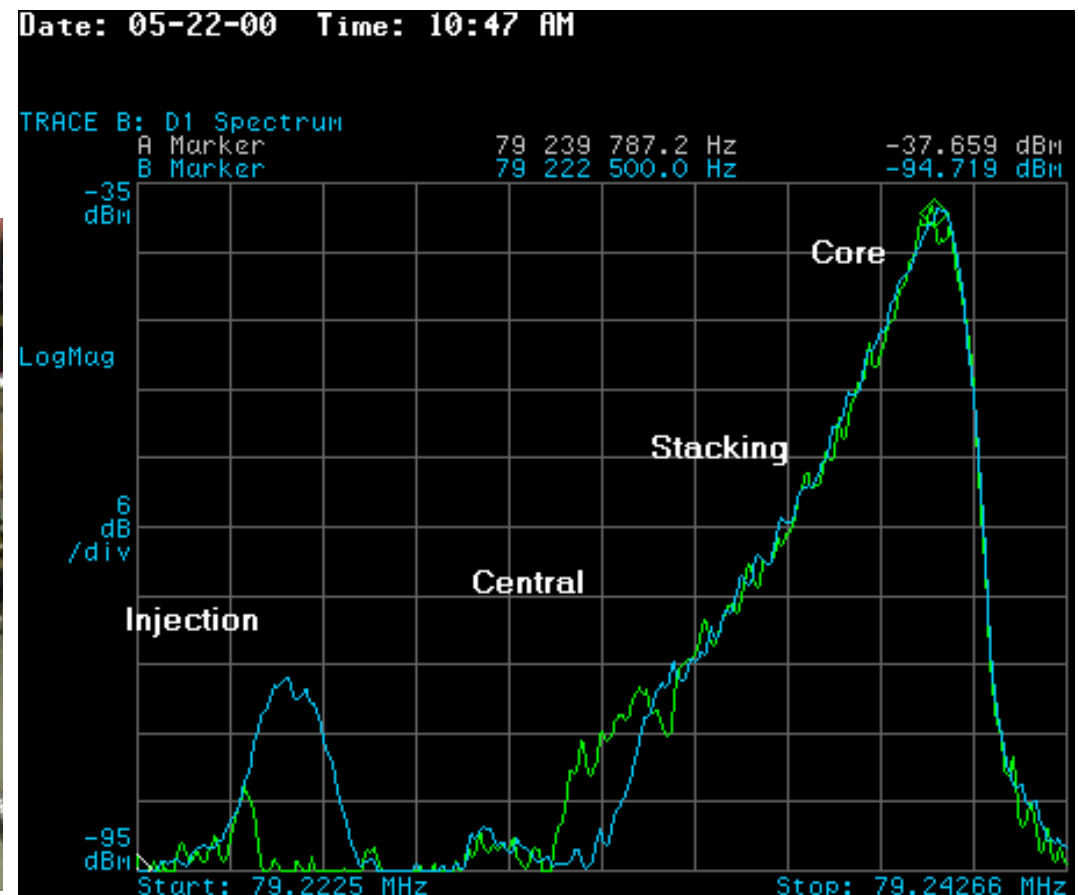
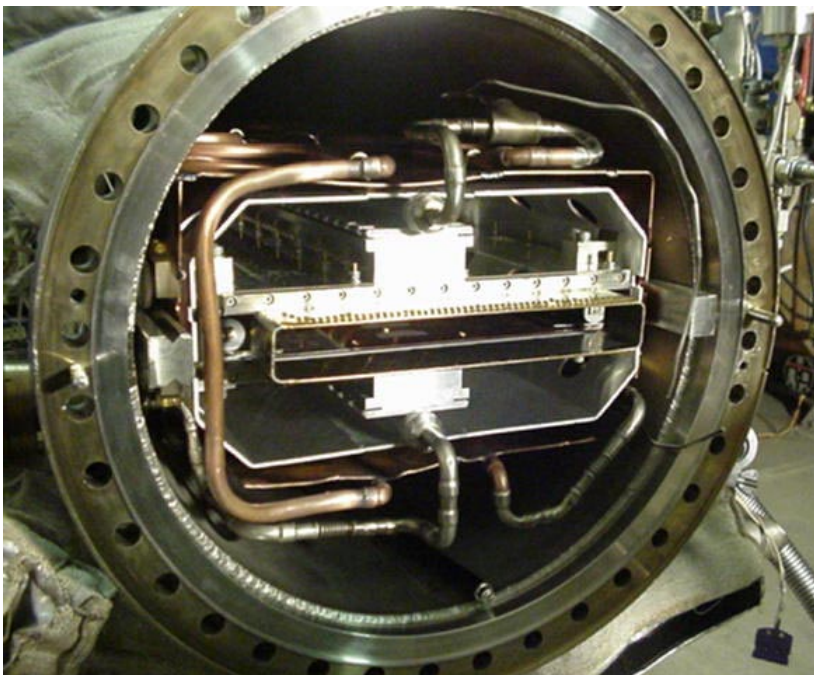
- Better Antiproton Transfer Efficiency

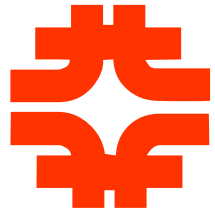
- Dedicated Accumulator to Recycler 8 GeV transfer line (AP5)



Accumulator Stacktail Stochastic Cooling System

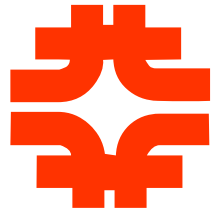
$$\Phi_0 = \frac{|\eta|}{4} \frac{W^2}{f_0} \frac{E_d}{pc} \frac{1}{\ln(f_{\max}/f_{\min})}$$



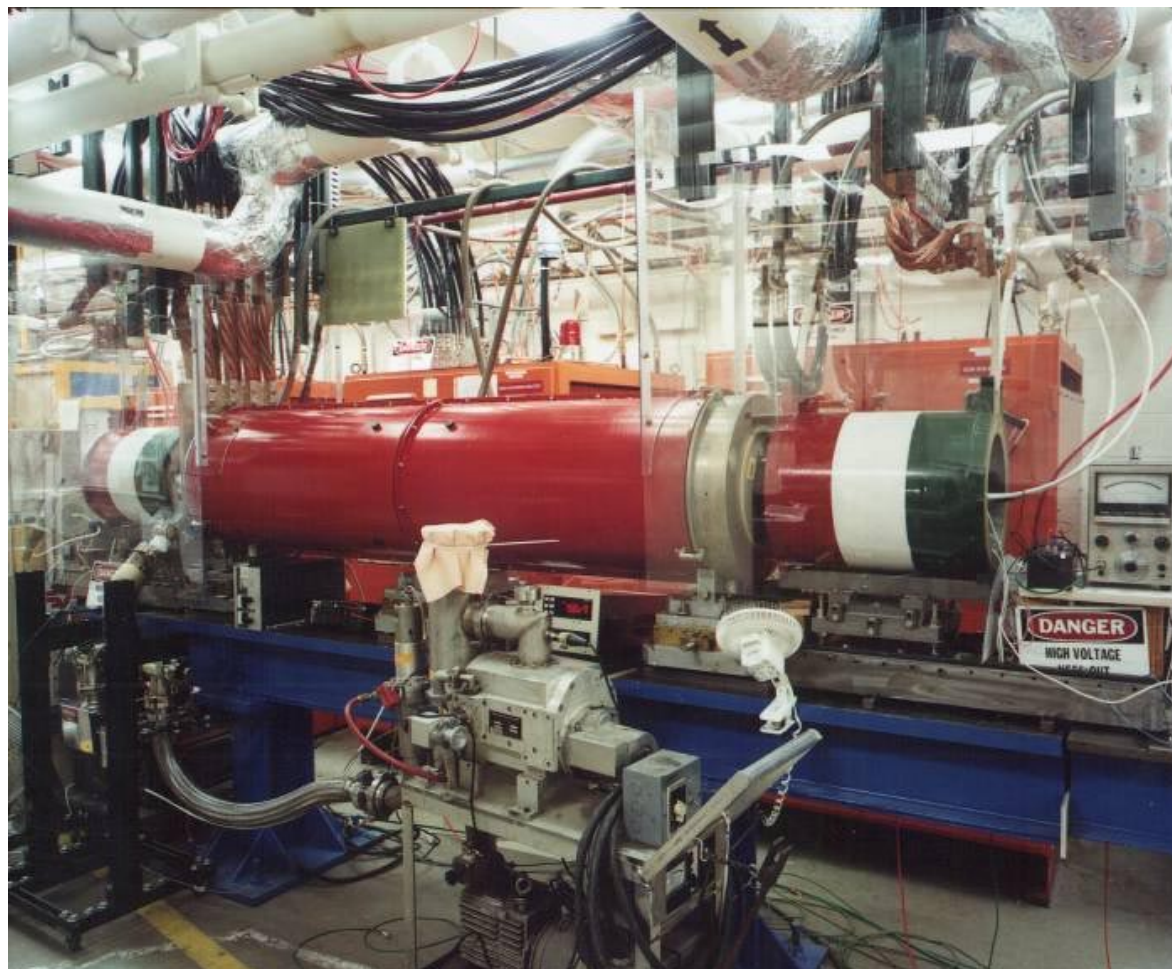


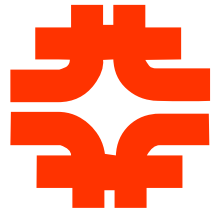
Recycler Electron Cooling





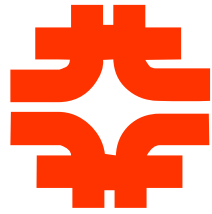
TEVATRON Electron Lens





Run 2b Organizational Goals for CY2001

- Design Report Rough Draft for Accelerator Advisory Committee (AAC) meeting (May 21-22, 2001)
 - Description of overall Run 2b plan.
 - Only the scope of each Run 2b project is included.
 - Posted on the WEB at <http://cosmo.fnal.gov/run2b/Documents/>
- Design Report finished by October 1, 2001
 - Will include the scope, resource requirements, and schedule for each Run 2b project.
- Dedicated Run 2b project review by the AAC in December of 2001
- Regular (weekly) project meetings



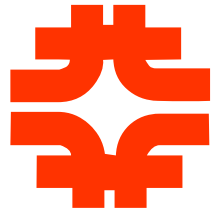
Present Technical Progress on Run 2b Projects

- Slip Stacking

- ☐ Testing of DSP algorithms in low level RF has begun
- ☐ Low intensity beam trials to start before May shutdown
- ☐ Simulations of slip-stacking without beam loading replicated
- ☐ Simulations of slip-stacking with beam loading underway.

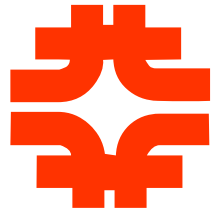
- Beam loading

- ☐ RF feedback at fundamental operational
- ☐ Prototype RF feedback at $m=1$ lines to be tested summer 2001
- ☐ IIR design awaiting results of simulations of slip-stacking with beam loading.



Present Technical Progress on Run 2b Projects

- AP5 line
 - Reverse proton tuneup for shot setup at about 1/2 hour
 - Redesign of 8 GeV AP3-AP1 lattice almost complete.
 - Power supply reconfiguration of 8 GeV AP3-AP1 and 120 GeV AP1 to take place during July 2001 shutdown
 - Transfer function measurements of 8 GeV P1-AP3 beam lines to begin May 2001.
- AP2 & Debuncher Aperture Upgrades
 - Optics redesign has been started
 - Transfer function measurements during May 2001 shutdown
 - BPM system design with CDF (Ohio State) has begun
 - Final installment of Debuncher Injection region improvements finished during May 2001 shutdown



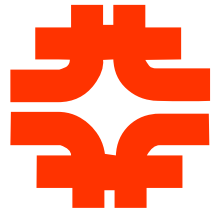
Present Technical Progress on Run 2b Projects

● Solid Lens R&D

- ☐ ANSYS mechanical and magnetic model of present lens nearly complete.
- ☐ Initial MARS tracking results using ANSYS output as input have been completed (CDF- Bussey)
- ☐ Fatigue tests of diffusion bonding underway.
- ☐ 8 cm diffusion bonded mechanical design underway. Fabrication to begin in Fall 2001
- ☐ No-beam Target Sweeping tests to begin Summer 2001

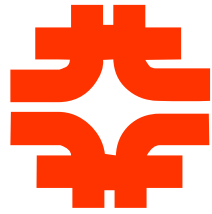
● Accumulator Cooling

- ☐ Not started



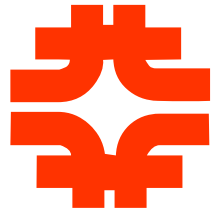
Present Technical Progress on Run 2b Projects

- Recycler Electron Cooling
 - High voltage testing of Pelletron complete
 - Electron beam re-circulation tests started.
 - Successful re-circulation through U-band accomplished!
 - Construction of long beam-line mock-up well underway.
 - Preliminary civil construction design for MI-30 has been started.
- Debuncher Lattice Upgrades
 - Definition of beam studies just starting.
- Linac Ion Source
 - Not started



Present Technical Progress on Run 2b Projects

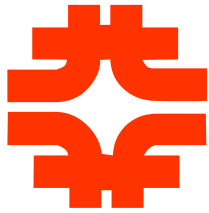
- TEV Tune shift compensation
 - Prototype system installed in TEVATRON
 - Tune shift of bunches observed
 - Future plans are awaiting outcome of TEV tests.
- Booster ramped correctors
 - Single sector linear electronics tested.
 - Power supply limitations require global software control.
- Booster cogging
 - First prototype successfully tested but caused large radial position excursions
 - Second prototype is built and lab tests are nearly complete. Beam tests will start before summer.



Present Technical Progress on Run 2b Projects

- TEV. Long dampers
 - Design of 36 x 36 digital under-sampled system has begun
- TEV Beam loading
 - Not started
- Liquid Lens R&D
 - Just finished second Fermilab review of BINP project.
 - 3rd lens prototype under construction with new titanium alloy.
 - Fermilab will receive liquid lithium magnetic pumping system this summer.
 - Fermilab will receive power supply this fall.

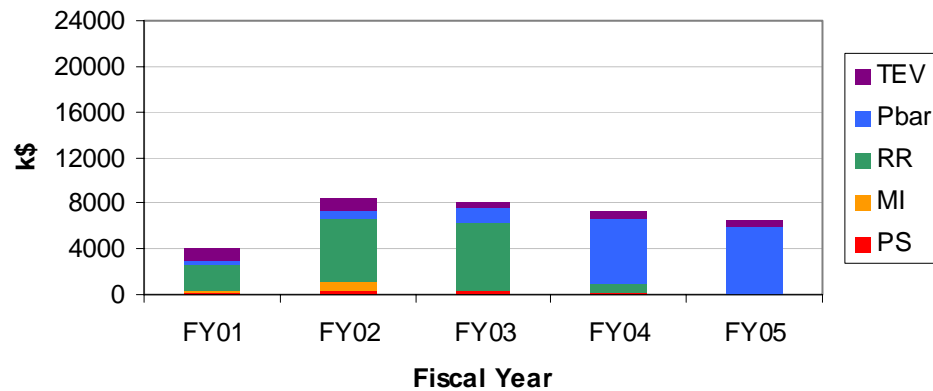
[illegible]



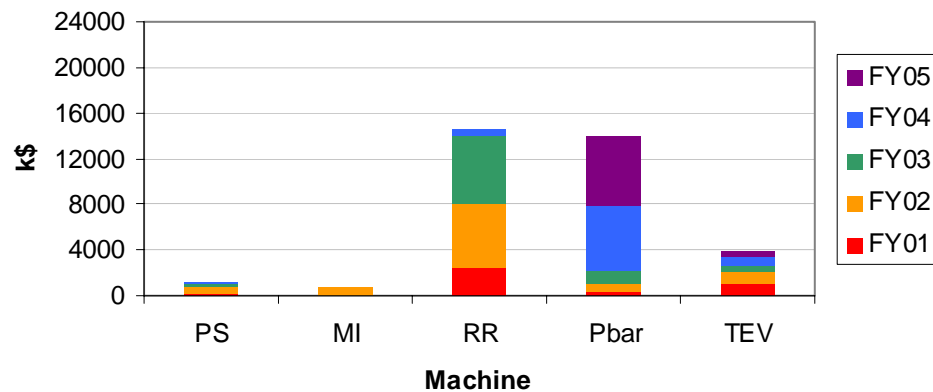
Total Cost for Run Iib

(WPAS version)

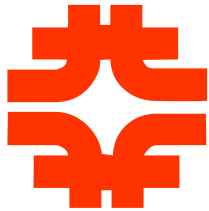
Total Cost



Total Cost

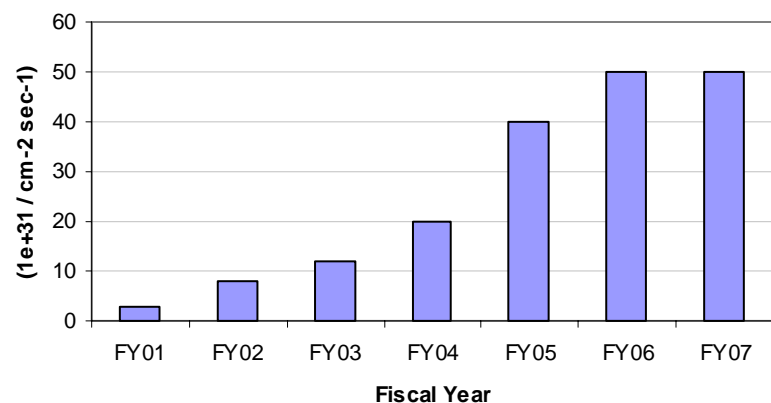


	Total					
	FY01	FY02	FY03	FY04	FY05	Total
PS	249	367	389	231	0	1235
MI	77	693	0	0	0	770
RR	2384	5637	5960	600	0	14580
Pbar	329	673	1128	5824	5987	13940
TEV	1000	1110	555	648	463	3775
Total	4038	8479	8032	7302	6449	34300

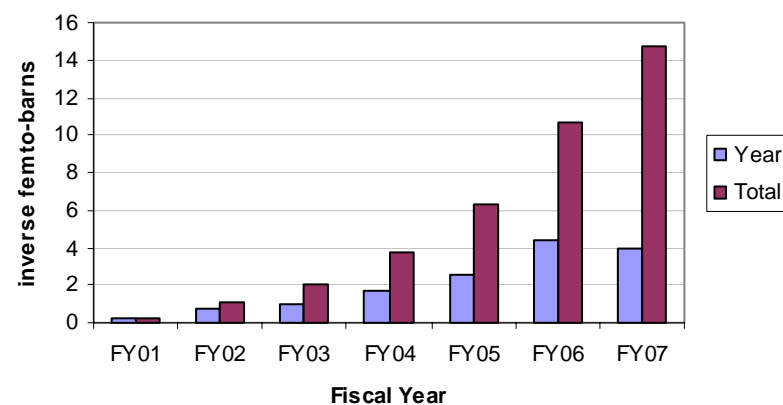


Run IIb Luminosity Schedule

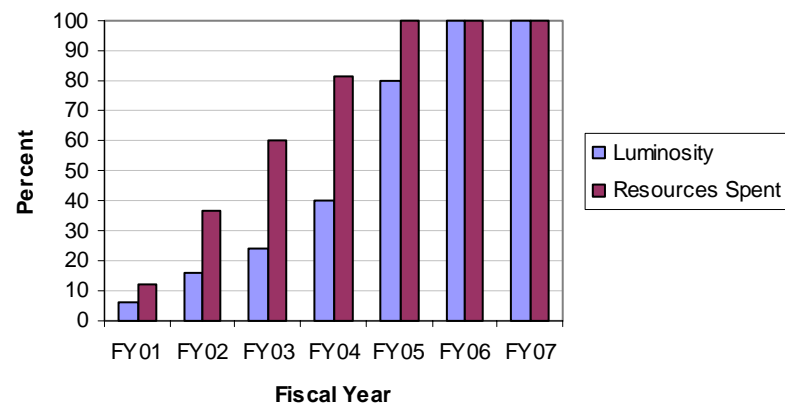
Initial Store Luminosity

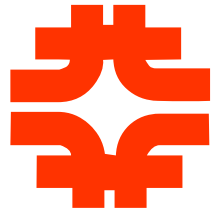


Integrated Luminosity



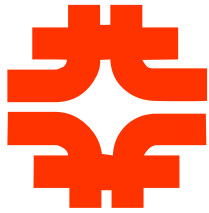
Initial Luminosity & Resources Spent





Conclusions

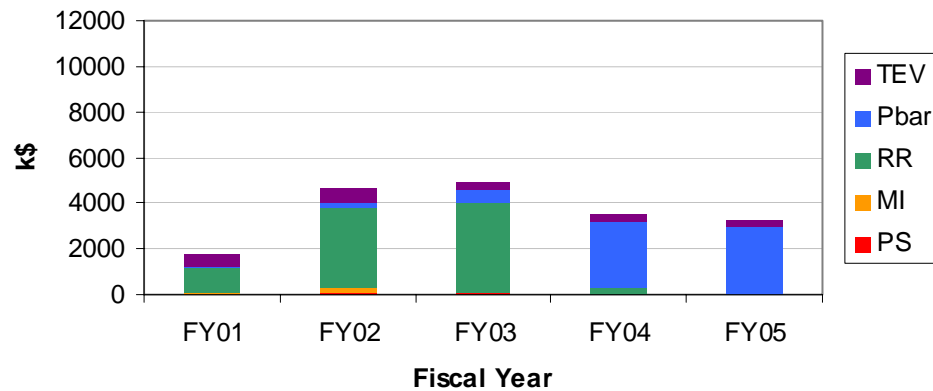
- Run IIB Accelerator plan defined
- Project Team being put in place
- Considerable technical progress
- Thorough technical review planned for the fall of 2001
- Goal is to achieve more than 15 fb^{-1} of integrated luminosity by 2007



M & S Cost for Run IIb

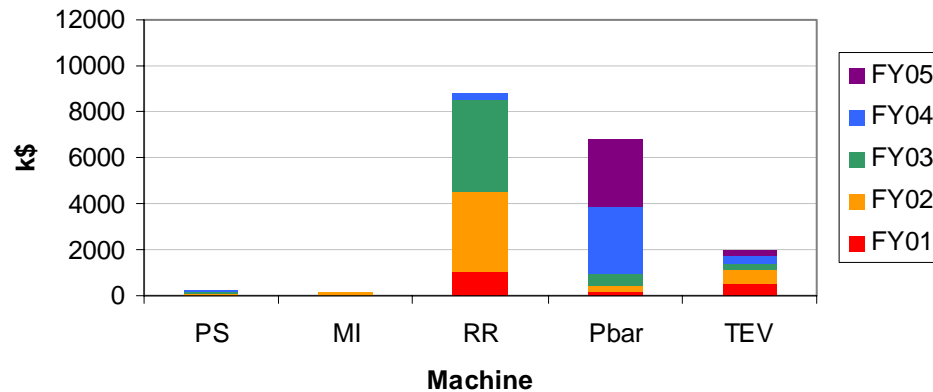
(WPAS version)

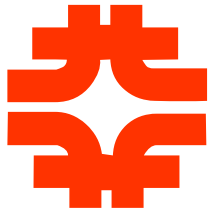
M & S



	M&S					
	FY01	FY02	FY03	FY04	FY05	Total
PS	43	67	73	38	0	220
MI	20	180	0	0	0	200
RR	1050	3500	4000	250	0	8800
Pbar	145	285	510	2890	2985	6815
TEV	500	600	300	350	250	2000
Total	1758	4632	4883	3528	3235	18035

M & S

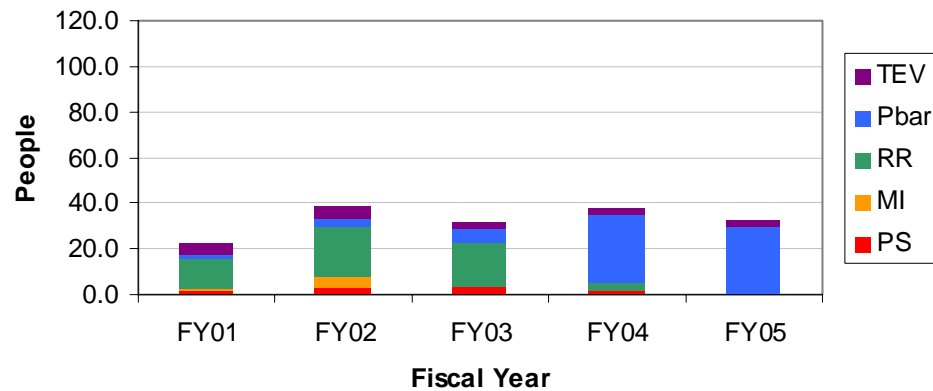




Labor Cost for Run IIb

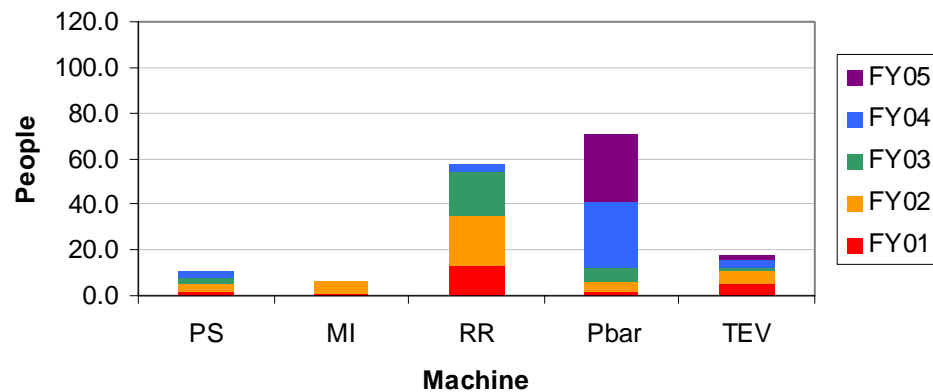
(WPAS version)

Total Labor



	Labor					
	FY01	FY02	FY03	FY04	FY05	Total
PS	2.1	3.0	3.2	1.9	0.0	10.2
MI	0.6	5.1	0.0	0.0	0.0	5.7
RR	13.3	21.4	19.6	3.5	0.0	57.8
Pbar	1.8	3.9	6.2	29.3	30.0	71.3
TEV	5.0	5.1	2.6	3.0	2.1	17.8
Total	22.8	38.5	31.5	37.7	32.1	162.7

Total Labor



	Labor\$					
	FY01	FY02	FY03	FY04	FY05	Total
PS	206	300	316	194	0	1015
MI	57	513	0	0	0	570
RR	1334	2137	1960	350	0	5780
Pbar	184	388	618	2934	3002	7125
TEV	500	510	255	298	213	1775
Total	2280	3847	3149	3775	3214	16265

[illegible]



	Y 1	Y 2	Y 3	Y 4	Y 5
	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S
RR					
Electron Cooling					
AP5 line					
Design					
Civil					
Technical Components					
Pbar					
Target Station					
Solid Lens R&D					
Liquid Lens R&D					
Beam Sweeping					
Debuncher					
Aperture					
BPM System					
Moveable Quads					
Dipole Beam Pipe					
DRF1-1					
Lattice Upgrades					
Coupling Correction					
Resonance Correction					
Gamma - t ramp					
Dispersion Correction					



	Y 1	Y 2	Y 3	Y 4	Y 5
	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S
Accumulator					
StackTail Betatron Cooling					
Core Tranverse Cooling					
StackTail Pickups					
Beam Lines					
Beam Position System					
AP2 line					
Aperture					
Left Bends					
Correctors					
Chromatic Correction					
AP1 Line					
EPB dipole replacements					
F17 Cmagnet Replacements					
TEV					
Beam-Beam Tune Shift Comp					
Beam Loading Compensation					
Longitudinal Dampers					